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OBSERVATION ON THE URINOGENITAL PAPILLA AND SEXUAL DIMORPHISM IN SOME INDIAN GOBIIDS (GOBIIDAE : TELEOSTEI)

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ABSTRACT

A thorough comparative study on the urinogenital papilla and sexual dimorphism has been made for the first time in both the sexes of twelve Indian gobiids - *Glassogobius giuris* (Hamilton); *Acentrogobius cyanomos* (Bleeker); *Eleotriodes muralis* (Valenciennes); *Parapocryptes serperaster* (Richardson); *Apocryptes bato* (Hamilton); *Scartclaos viridis* (Hamilton); *Boleophthalmus boddarti* (Pallas), *Periophthalmus schlosseri* (Pallas); P. koelreuteri (Pallas); *Taenioides anguillaris* (Linnaeus); *T. buchanani* (Day); *Odontamblyopus rubicundus* (Hamilton). The urinogenital papilla, originating as a free muscular organ from the ventral surface of the body-wall and shortly behind anus, is present in both the sexes. It is an important organ of primary sex recognition in all the species. In case of male the papilla is conical, broad at the base and in female it is either flattened, distally truncated or bluntly rounded. The presence of permanent colour mark over the specific region of the body surface is another secondary sexual character in a few species. Besides, colouration may also be a nuptial secondary sex character developed in some during peak breeding season. The enlargement and colouration of the organ is subject to seasonal variations parallel to the seasonal gonadal cycle. The histological architecture of the papilla shows a high degree of cellular specialization and an interrelationship to the urinary and genital ducts. The functional efficacy and significance of the papilla in the breeding biology of these fishes has been discussed.

Keywords : Gobiidae, Sexual dimorphism, Urinogenital papilla

INTRODUCTION

The urinogenital papilla and sexual dimorphism have been reported in fishes from time to time by different authors (Eggert, 1931; Hora and Law, 1941; Mookerjee, Mazumdar and Dasgupta 1941; Parkar, 1941; Weisel 1949; Braungart, 1951; Lagler and chin, 1951; Clark, 1959; Egami, 1960; Sinha, 1961; Kamalaveni, 1961 a; Sircar, 1970). Eggert (1931) in the course of his description of the male reproductive system of gobiiform and bleniiform fishes found errotile tissue in the urinogenital papilla of some of the gobies. Egami (1960) reported the presence of the urinogenital papilla e and seasonal variations in their structure in both the

sexes of several species of Japanese gobies. But these works have addressed only the gross merphological aspects of the urinogenital papilla in gobiids.

The nature of the urinogenital papilla, its seasonal variations parallel to those of the gonadal activity, interrelationship between the genital and urinary dicts and sexual dimorphism have not been worked out on both the sexes in gobiids and hence, a comparative study on these aspects has been undertaken for the first time on the Indian gobiids.

MATERIAL AND METHODS

Live specimens of different maturity stages of twelve gobiids were collected at random from river, pond and muddy estuaries of Bay of Bengal, Midnapur, West Bengal during different seasons of the year. Any sorts of variation either in structural details or in the seasonal or sexual colour mark over the general body surface and fins in these fishes was particularly recorded. The papillae or both males and females were dissected out and quickly fixed in Bouin's fluid and Zanker's fluid. Serial sections of the urinogenital papilla were cut at 6-8 μ thick and stained in Delafield's haematoxylin, Iron Haematoxylin, and counterstained with Eosin. Picroindigo carmine and Mallory's triple stain were also used to identify and study the musculature and connective tissue elements in the papilla.

OBSERVATION

With relation to Urinogenital papilla

Glossogobius giuris (Male)

Urinogenital papilla or "Papilla Urogenitalis" is a free muscular abruptly conical structure which arises from behind the anus and situated almost midventrally and projected as an outgrowth infront of the starting point of the anal fin. It is visible from outside; if pressure is exerted upon the ventral side of the anal opening in live specimen, the papilla will be erected. The urinary and genital openings, though very minute, lie separately at the distal bluntly pointed tip. The common vas deferens and the common ureter enters independently into the body of the urinogenital papilla and throughout the length of the papilla the two ducts remain distinctly separate. During breeding season the enlargement and the pigmentation of the papilla has been particularly observed and in the non-breeding season the papilla is reduced in size and devoid of pigmentation. Again from the preparatory period the papilla elongates gradually. The anus and urinogenital papilla are distinct from each other but at the base of the papilla it is confluent with the lower margin of the anus. The anal opening is circular and guarded by a sphincter (Text-fig.1).

The histology (pl.1 fig.1) of the urinogenital papilla reveals peculiarities. The skin or the outer covering is made up of stratified squamous epithelium with many mucous glands and with a thin layer of subcutaneous connective tissue. There is a thin basement membrane separating these two layers. Inner to the subcutaneous connective tissue layer, there lies the thick longitudinal muscle bands with several blood sinuses. Inner to this there is an

equally thick circular muscle layer which forms the inner core of the papilla. The whole length of the papilla is traversed by the conduits of the accessory glands of the testes, the spermatic duct and urinary duct. The two ducts are embedded at the centre of the papilla. The space between the ducts and the circular muscle layer is filled up by the reticular connective tissue which is disposed at the lateral side only. At the proximal end of the accessory glands of the testes, some of the glandular follicles become enlarged and form channels or conduits, slowly converging to open into the common spermatic duct. As the conduits traverse the length of the papilla they converge and open in to the main spermatic duct either collectively or individually. The common duct, thus formed by the union of the conduits and the spermatic duct can be named as spermigland duct. The inner wall of the spermatic duct is composed of short columner epithelial cells. The sperimigland duct runs below the urinary duct which is composed of tall columner epithelial cells. The two ducts run, one above the other without union, up to the tip of the urinogenital papilla.

The male urinogenital papilla of *Periophthalmus schlosseri, P. koelreuteri, Acentrogobius cyanomos* shows the same morphological and histological pecularities, as that of male *G. giuris.*

Glossogobius giuris (Female)

The urinogenital papilla is a free muscular, spically flattened structure which arises like that of the male from behind the anus and situated almost mid ventrally and projected as an out growth infront of the starting point of the anal fin. It is also visible to the naked eye. Unlike the male tip of the flattened papilla is truncated. The dorsal aspect of the papilla is medially ridged but its ventral side is more or less smooth. During the breeding season enlargement of the papilla takes place and in the off-season the papilla is indistinctly visible (Text-fig.2).

Histologically (Pl.fig.2) the urinogenital papilla is to some extent different from that of the male regarding disposition of different layers of muscles and structure of the urinary and genital ducts. The outer stratified squamous epithelium that forms the skin of the papilla is not provided with mucous secreting glands and this layer is very thin. The subcutaneous connective tissue is visibly distinct only at the lateral sides of the papilla. Unlike the male, the longitudinal muscles are absent or very few. The loose circular muscle layer forms the inner core of the papilla. The oviduct is surrounded ventrally by reticular connective tissue. The urinary duct is oval and the inner wall is covered with smooth cells. Genital duct has infolded lumen and is covered internally with short columner cells. The lumen of the uninary duct is more spacious. Like the male the two ducts starting from the base to the tip of the papilla run separately without union.

The u.g. papilla of female *P. koelreuteri* is exactly similar in structure to that of female *G. giuris.*

Parapocryptes serperaster (Male)

The urinogenital papilla or pseudocopulatory organ is a conical, muscular, elongated structure placed behind that very close to the anus. The

sphincter muscles surrounding the anus and the urinogenital papilla house a narrow elliptical groove which may be called as "integumentary cloaca". During preparatory period the papilla is comparatively short and white in colour. During the breeding season the pailla is exceedingly long, stout, reddish in colour and hangs down from the body wall. During the post-breeding season the size of the papilla is reduced to a mere projection which is white in colour but the groove or depression surrounding the papilla and anus remains unchanged. The papilla, again, begins to enlarge at the onset of the breeding period. The urinary and genital passages remain separate at the tip of the papilla (Text-fig.5).

Histologically (Pl.1.fig.5) stratified squamous epithelium forms a thick outer limit of the papilla. Subcutaneous connective tissue is very thin at the side. The major portion of the papilla is occupied by the circular muscle which lies beneath the subcutaneoues connective tissue. Inner to this and adjoining the two ducts a bed of loose connective tissue is prominent in the mid ventral region. The longitudinal muscle are interposed between the circular muscle and loose connective tissue layer. The urinary duct is very spacious whereas the genital duct is rather narrow and is ventral to the urinary duct. The inner wall of both the ducts are lined with tall and short columner epithelial cells. The two ducts traverse the urinogenital papilla and ultimately open at the tip independently.

The morphology, histology and seasonal changes of the male urinogenital papilla are more or less similar in *Apoeryptes bato, Boleophthalmus boddarti, Taenioides anguillaris, T. buchanani, Odontamblyopus rubicundus* except in having "integumentary cloaca" in them.

Acentrogobius cyanomos (Female)

The urinogenital papilla is an oval, brown, muscular structure placed inside a rounded groove on the ventral body wall just behind the anus. The papilla begins to enlarge and differentiate form the body wall and anus starting from the preparatary period right up to the peak of the breeding season. Due to the presence of a groove encircling the proximal end of the genital papilla during the peak of the breeding season it may be well differentiated from the anus and its adjoining area. At the tip of the papilla two distinct apertures, urinary and genital, open separately to the exterior (Text-fig.3).

Histologically (Pl.1.fig.3) the urinogenital papilla has much similarity with that of male G. giuris in the disposition of different muscle layers, inspite of the morphological differences between the two. The stratified squamous epithelium, as usual forms the outer skin of the papilla and this layer is provided with mucous secrcting gland cells. Unlike G. giuris, the subcutaneous conucetive tissue is very broad and underneath this layer longitudinal muscle layers are present. Inner to the longitudinal muscle layer, circular muscles form the inner core of the papilla. The outer wall of the urinary and genital ducts are made up of a thin layer of reticular connective tissue. The inner wall of the two ducts is also lined with tall and short columner epithelial cells. The lumen of the unirary duct situated dorsal to the oviduct is more spacious and the two ducts run

separately through the papilla up to its tip to open to the exterior.

The morphology, histology and seasonal changes of female urinogenital papilla are found similar in *Eleotriodes muralis, Parapocryptes serperaster, Apocryptes bato, Boleophthalmus boddarti, Periophthalmus schlosseri, Taenioides anguillaris, T. buchanani, Odontamblyopus rubricundus.* "Integumentary cloaca" is found only in *Parapocryptes serperaster.*

Eleotriodes muralis (Male)

The urinogenital papilla is conical, muscular, elongated brown coloured structure and is situated behind the anal aperture. The proximal part of the papilla is placed inside a round groove on the ventral body-wall and its dorsal tip is projected outside from the body-wall, during preparatory period. During breeding season the urinogenital papilla is comparatively enlarged and looks like alonging appendage. During the post breeding season the papilla is reduced in length to an exceedingly minute form. The urinary and genital apertures are not confluent but remain completely separated at the tip of the papilla (Text-fig. 4).

Histologically (Pl.1.fig.4) the outer integument of the urinogenital papilla is made up of stratified squamous epithelium which is separated from the subcutaneous connective tissue by a thin basement membrane. Inner to the subcutanous connective tissue, there is a circular connective tissue lamina. Inner to this lamina, reticular connective tissue, giving spongy appearence, occupies a major portion of the papilla, longitudinal muscle bands being absent in this case. Instead of reticular connective tissue abounds in large number of blood sinuses, a condition which does not exist in any other fish reported previously. The ducts, urinary and genital, are surrounded by well-developed circular muscles. The two ducts remain separated althroughout loose connective tissue.

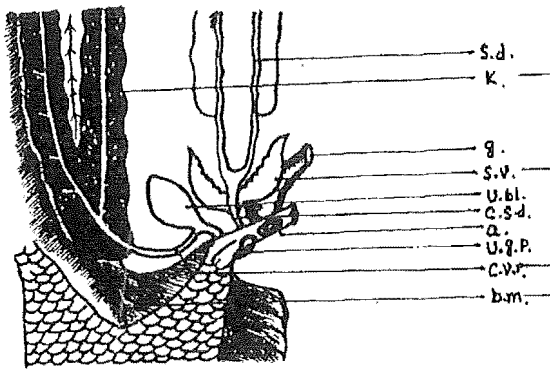
With relation to sexual dimorphism

Sexual dimorphism is very well marked in all the twelve species of gobiids by the presence of two dissimilar types of urinogenital papilla in two sexes. In case of male it is conical and in the female oval. Moreover, only in case of female *Acentrogobius cyanomos,* a black spot is present at the base of the caudal peduncle and in the male it is wanting. The spot is present throughout the year in the females. In the male *Periophthalmus schlosseri,* the first dorsal fin has a black band, becoming cobalt externally and with a scarlet edging whereas in the female the first dorsal fin is moderatly developed unlike male. The spot is seen in all the seasons of the year. During the breeding season several black patches have been found to be developed on both the sides of truck and caudal in the female of *Periophthalmus schlosseri* and in the male of *P. koelreuteri.* Regarding other gobiids brighter colouration is developed among the males during the peak of the breeding season.

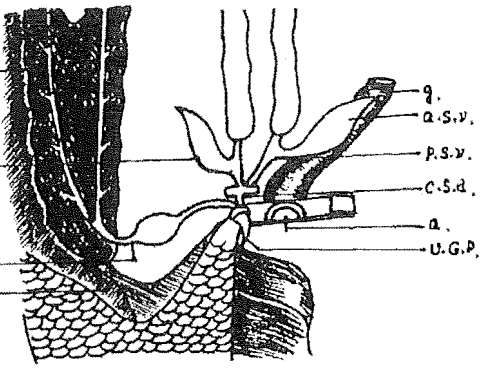
DISCUSSION

With relation to urinogenital papilla

Of the twelve species studied here, the



TEXT - FIGURE -1



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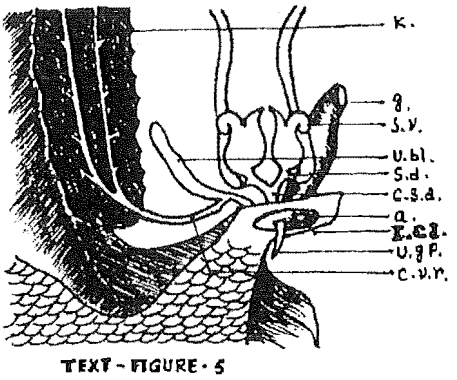

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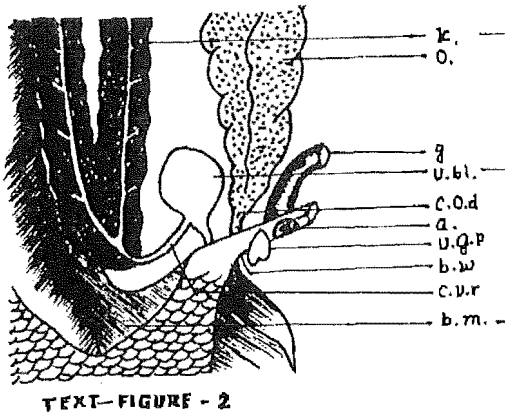
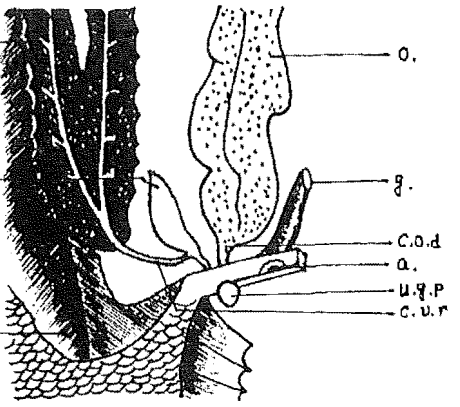


TEXT– FIGURE - 2



TEXT – FIGURE - 3

URINO-GENITAL ORGANS

Text-figure 1 - Glossagabius, Text-Figures 2 - G. giuris, Text-Figures 3 - Acentrogobius cyanomos , Text-Figure 4 - Eleotriods muralis, Text-figure 5 - Parapoeryptes serperaster

k- Kidney; s.d - Sperm duct; g - gut; S.V - Seminal vessicle; ug.p. - Urinogenital papilla, u.bl. - Urinary bladder; c.s.d. - Common sperm duct; a. - Anua; I.cl - Integumentory cloaca; c.ur - Common ureter; c.o.d. - Common Oviduct; b.m - Body muscle; b.w. - Body wall. p.sv - Posterior Seminar vessicle; a.s.v. - Anterior seminal vessicle;

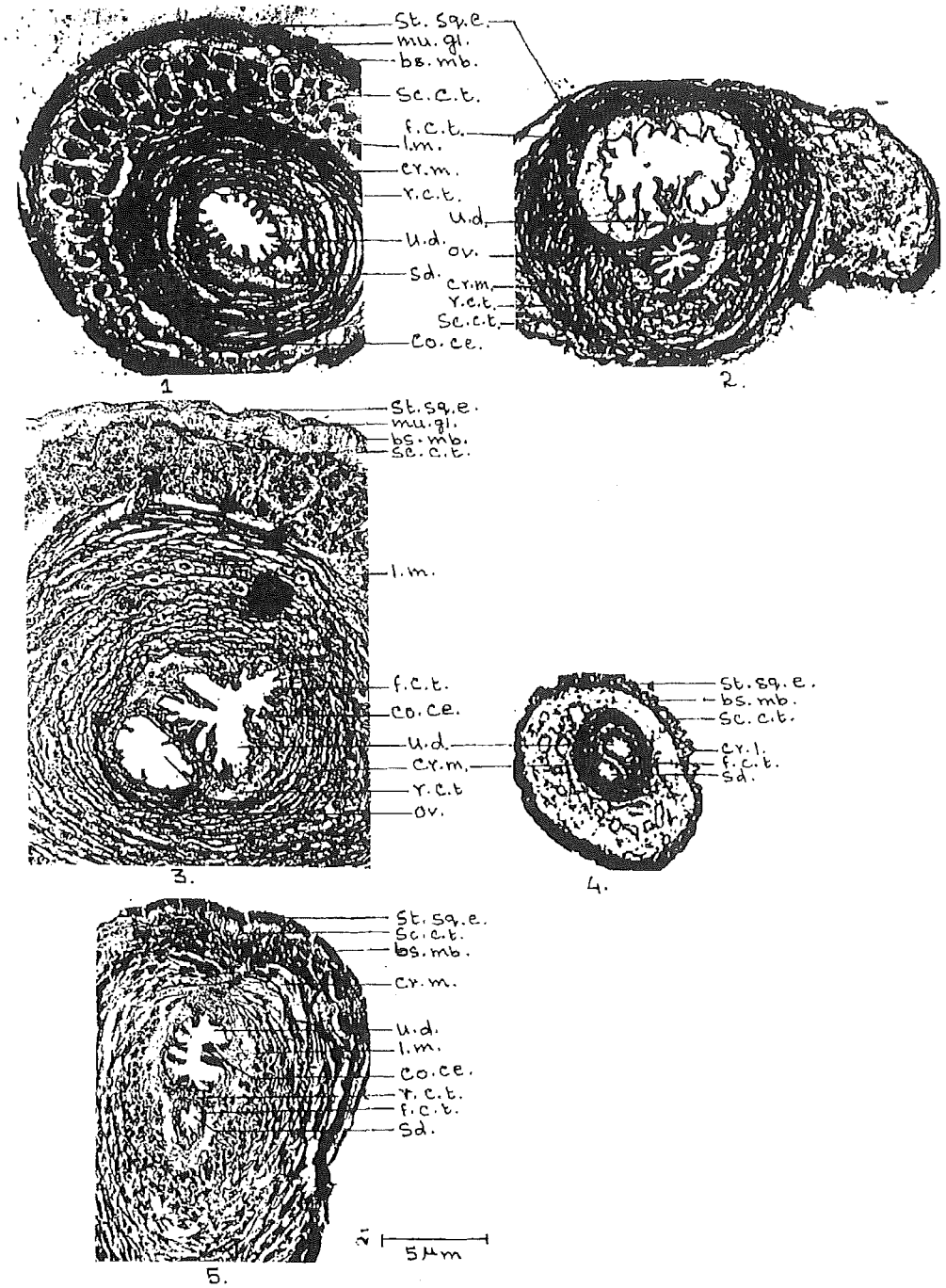


Plate 1

Transverse section of urinogenital papillae of Glossogobius giuris, Acentrogobius cyanosmos; Eleolriodes muralis and Parapocryptes serperaster.

Fig.1 : Transverse section through the male urinogenital papilla of Glossogobius giuris.

Fig.2 : Transverse section through the female urinogenital papilla of Glossogobius giuris.

Fig.3 : Transverse section through the female urinogenital papilla of Acentrogobius cyanosmos.

Fig.4 : Transverse section through the male urinogenital papilla of Eleothriodes muralis.

Fig.5 : Transverse section through the male urinogenital papilla of Parapocryptes serperaster.

ABBREVIATIONS

bs.mb. Basement memberance co.ce., Columber epithelial cells., cr.m. - Circular muscles; fe.t. - Fibrous connective tissue; l.m.- Longitudinal muscles; Sc.c.t. - Subcutaneous connective tissue; Sd - Spermduct; st.sq.c- startified squamous epithelium; u.d. - uninany duct; mu.gl. mucous glands; ov. Oviduct. r.c.t. Reticular Connective tissue; Cr.l. - Circular lamina.

urinogenital papilla has been found in both the sexes. In all the species the papilla is free, muscular organ which is visible to the naked eye and can easily be raised with needle. In case of male the papilla is conical, board at the base and tapering posteriorly. Similarly in female the papilla is either flattened, distally truncated structure as in *Glossocgobius giuris* and *Periophthalmus koelreuteri* or bluntly rounded in the rest of the species, studied here. It arises from the ventral surface of the body-wall shortly behind the anus. The urinary and genital apertures open to the exterior individually, in both the sexes, at the tip of the papilla. The enlargement and colouration of the organ is subject to seasonal variations in parallel with the seasonal gonadal cycle.

In course of his description of the male reproductive system in a number of species Gobiiformes and Bleniiformes, Eggert (1913) found erectile tissue in the urinogenital papilla of some gobies. Hora and Law (1914) have reported the presence of a prominent urinogenital papilla or *papilla urogenitalis* amongst certain species of *Batasio* (Bagridae). Mookerjee, Mazumdar and Dasgupta (1941) have recorded the presence of the papilla or pseudocopulatory organ in both the sexes of *Heteropneustes fossilis* and *Olarias batrachus.* They say that there is a median cleft on the ventral surface of the female urimogenital papilla representing the urinogenital opening, while in the male this oping lies at the tip of the papilla. The formation of a temporary conspicuous papilla in femalies at the time of oviposition as reported by Parker (1942) for *Perca flavesgens* has not been observed in any of the species worked out by the present author. Weisel (1949) has mentioned the occurence of the urinogenital papilla in *Gillichthys mirabilis.* He noticed variations in the size of the papilla in different seasons of the year but he could not correlate it with the sexual cycle of the fish. Braungart (1951) made a comparative study of the reproductive system of several teleost fishes. He observed the presence of a urinogenital papilla in black crappie, *Pomoxis nigromaculatus.* In this fish both the urinary and genital ducts open to the outside of the body separately through separate orifices, although both open to the outside on the same papilla. The present study corroborates with Braungart's findings so far as the opening of the two individual ducts to the outside independently at the tip of the papilla is concerned. Lagler and Chin (1951) have recorded lobate genital papilla in the harmaphroditic percid fish, *Boleosoma nigrum.* Clerk (1959) has recorded in a harmaphroditic serranid fish, *Serranalus subuligarius,* the erection of the genital papilla when the sperm is released from a small opening at the tip. Egami (1960) reported the presence of the urinogenital papilla in both the sexes of several species of Japanese gobies. According to him the papilla is different both in size and shape between the two sexes. He also observed that, at least in some species, the enlargement of the organ is subject to seasonal variations in parallel with the seasonal changes in gonadal activity. The present study corroborates with Egami's findings form the morphological point of view but he did not describe the histological nature of the papills. Nair (1960) reported on the papilla in the male *Heteropneustes fossilis* and

Rita rita. In *Rita rita* the papilla shows a large number of blood sinuses in its substance, which probably help in the erection of the papilla. The present author support Nair's observation on the basis of his finding on some gobies. Kamalaveni (1961 *a*) has reported the presence of urinogenital papilla in the males of *Heteropeustes fossilis* and *Clarias batrachus;* in both the sexes of *Wallago attu; Eutropiichalus vacha; Notopterus notopterus; Notopterus chitala* and *Mastocembalus armatus*. Though Mookerjee, Mazumdar and Dasgupta (1941) have recorded the presence of the papilla in the females of *Heterpneustes fossilis* and *Clarias batrachus*, yet Kamalveni (1961d) has not observed it in the females of these two species. Kamalaveni did not furnish any histological data of the papilla nor did make any comment on the organ in general dicussion. While describing the urinogenital organs of *Wallago attu*, Sinha (1961) recorded the presence of the papilla or "pseudocopulatory papilla" in both the sexes. It is slender and pointed n the male but broad and truncated at the apex in the female. Sinha's (1961) findings are applicable in some of the gobiids under the present investigation.

Sircar (1970) has observed the papilla in the males only of *Heteropheustes fosslis, Clarias batrachus* and *Eutropiichthys murius*. Morphology and histology of the papilla have been studied and interrelationship of the urinary and genital ducts within the urinogenital papilla has been investigated by serial sections. The urinary and sperm ducts run side by side in the papilla for the major part of its length as in *Heteropneustes fossilis* and *Clarias batrachus* and the two ducts join. This colouration may be nuptial secondary sex character, because this brilliant colouration which developes at the peak of the breeding season soon starts disappearing after the spawn is over. This eolouration must have some recognition value or attracts to some extent the opposite sex during the peak season.

Davidson (1935) described a very peculiar secondary sex-character in the male pink salmon, *Onchorhycus gerbuscha*. With the approach of the breeding season the snout elongates and a hump is developed on the dorsal side which starts from behind the head and tapers caudally, the deepest portion being behind the dorsal fin. Parker and Brower (1935) discovered the appearence of a melanomerphic mark on the ventral fin of the male of *Fundulus heteroclitus*. These spots appear only during the breeding season. They termed as "nuptial secondary sex-character" by the authors. Fraser-Brunner (1940) recorded that in the family Ostractiontidae sexual dimorphism is of common occurrence. It consists of colour difference, depth of the body and form of the snout in the two sexes. In this studies of the morphology and embryology of two species of marine catfishes, *Bagre marinus* and *Galeichthys felis*. Merriman (1940) referred to the morphological differences between the male and female in both the species, Rosen and Gorden (1953) while working on the evolution of male genitalia in helleri, observed sexual dimorphism in them. By a complex series of morphogenetic processes, the anal fin of the male is transformed in to a gonopodium. Egami (1960) reported differencess both in shape and size of the

genital papilla in several species of Japanese gobies. No sexual dimorphism in the shape of the papilla was observed by him in immature gobies. Such instances of the absence of sexual dimorphism in immature fishes, where dimorphism is pronounced in the adult condition, has not been observed by the present investigator. Kamalaveni (1961 *a*) reported sexual dimorphism in *Heteropneustes fossils* and *Clarias batrachus*. She found no dimorphism in *Wallago attu* and *Mystus aor*. All the species worked upon here in connection with the present investigation are sexually dimorphic. Norman (1963, P. 232) wrote; "Sexual differences in the dentition are also known. In some Gobies and Blennies the males have dentition is not found as sexually dimorphic in any one of the twelve species of gobiids worked out by the present investigator. Sircar (1970) has reported pronounced sexual dimorphism among siluroid fishes, such as *Heteropneoustes follilis, Clarias batrachus, Eutropiichthys murias,* in all the species named above the male have a muscular, tapering urinogenital papilla and the cloaca is absent, the anal opening being distinct and separate. In the female of *Eutropiichthys murias,* a membranous flap-like structure has been found between the pelvic fins. The flap extends posterior up to the anus and then again starts from behind the anus and extends up to the base of the "genital pouch" or "accessory tube". The presence of a soft tubular "genital pouch" in the female and muscular tapering urinogenital papilla in the male is also a sexually dimorphic character.

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